Disclosure of the Invention

In accordance with the present invention there is provided a process for the conversion of sludges and carbonaceous materials, the process characterised by the steps of:

(a) Heating the material to be converted in a heating zone of a reactor in the absence of oxygen for the volatilisation of oil producing vapours, thereby producing both a vapour product and a solid residue or char;

(b) Contacting the vapour product and char in a reaction zone of the reactor at a determined Weight Hour Space Velocity ("WHSV") so as to promote vapour-phase catalytic reactions; and

(c) Removing and separating the gaseous products and char from the reactor.

Preferably, the gaseous products from the reactor may be condensed to produce oil and water. The oil and water may then be separated and the oil polished to remove char fines and any free water.

Still preferably, the inventory of char within the reactor is able to be adjusted to provide the required WHSV in the reaction zone of the reactor.

Still further preferably, the heating rate in the heating zone is between about 5 and 30°C/min.

The material to be converted may preferably be conveyed through the heating and reaction zones by a conveyor having a rotational speed of at least about 1 rpm.

Preferably, the conveyor is provided with paddles and rotates such that the paddle tip speed is between about 2 and 8 m/min.

Still preferably, less than about 5% of the char inventory is passed through the reactor in less than about 40 minutes.

The dried sludge is fed to, and char removed from the reactor by a means to ensure no ingress of air into the reactor, or egress of vapours from the reactor.

The temperature of the reactor is preferably at least 250°C. The temperature of the reactor is still preferably 400 to 450°C.

The process of the present invention may further comprise the additional step of drying the material to be converted to less than 5% moisture prior to introduction to the reactor.

In accordance with the present invention there is further provided an apparatus for the conversion of sludges and carbonaceous materials, the apparatus characterised by comprising a reactor having a heating zone and a reaction zone and a means for conveying the material through both zones of the reactor in turn, the heating zone having a material inlet and the reaction zone having a material outlet and a gaseous product outlet, wherein there is further provided a retention means for retaining the material within the reactor such that a desired Weight Hour Space Velocity ("WHSV") for the material is achieved.

Preferably, the means for conveying material is a conveyor that allows a level of back mixing of the material being conveyed.

In one form of the present invention the conveyor comprises in part an elongate shaft along at least a portion of the length of which are provided a plurality of paddles extending radially therefrom arranged to engage a bed of the material to be conveyed therethrough.

Preferably, the paddles are provided in a single row helical arrangement along the elongate shaft. The paddles preferably overlap along the length of the shaft.

horizontal, so as to substantially match or mimic the angle generated in the sludge/char bed as a result of the action of the conveyor 54.

A model of the apparatus 50 was constructed for a series of tests directed at examination of shaft/addle configuration, sludge/char bed inventory and shape, residence time and mixing characteristics.

The model consisted of a 240 mm diameter reactor shell, a conveyor shaft with paddles attached in a helical fashion, and a weir at the outlet end of the reactor, preventing the pellets from flowing out of the reactor until they reach a certain height. This model was bolted to a frame beneath an automatic feeder. A geared motor was used to drive the conveyor shaft of the reactor via a chain and sprocket arrangement. A variable speed drive ("VSD") was used to vary the motor speed.

The procedure used for this testing was essentially:

- Fill reactor with known mass of pellets
- Adjust VSD to provide desired shaft rotation speed
- Adjust feeder to provide desired feed rate
- Begin shaft rotation and pellet feeding simultaneously
- Collect all pellets leaving reactor
- After half an hour of operation, measure feed rate out of reactor
- If feed rate out is equal to feed rate in, reactor has reached steady state. If reactor has not reached steady state, continue monitoring feed rate out until steady state has been achieved
- Continue running the reactor until steady state is reached, then shut off the pellet feed and shaft rotation simultaneously
- Record the loadcell reading on the automatic feeder
- Measure the total mass of pellets displaced from reactor

The mass of pellets accumulated in or depleted from the bed can now be calculated, and the final bed inventory at steady state can be found.

Claims

1. A process for the conversion of sludges and carbonaceous materials, characterised in that the process comprises the steps of:

   (a) Heating the material to be converted in a heating zone of a reactor in the absence of oxygen for the volatilisation of oil producing vapours, thereby producing both a vapour product and a solid residue or char;

   (b) Contacting the vapour product and char in a reaction zone of the reactor at a determined Weight Hour Space Velocity ("WHSV") so as to promote vapour-phase catalytic reactions; and

   (c) Removing and separating the gaseous products and char from the reactor.

2. A process according to claim 1, wherein the gaseous products from the reactor are condensed to produce oil and water.

3. A process according to claim 2, wherein the oil and water are then separated and the oil polished to remove char fines and any free water.

4. A process according to any one of claims 1 to 3, wherein the inventory of char within the reactor is able to be adjusted to provide the required WHSV in the reaction zone of the reactor.

5. A process according to any one of the preceding claims, wherein the heating rate in the heating zone is between about 5 and 30°C/min.

6. A process according to any one of the preceding claims, wherein the material is conveyed through the heating and reaction zones by a conveyor having a rotational speed of at least about 1 rpm.

7. A process according to claim 6, wherein the conveyor is provided with paddles and rotates such that the paddle tip speed is between about 2 and 8 m/min.

8. A process according to any one of the preceding claims, wherein less than about 5% of the char inventory is passed through the reactor in less than about 40 minutes.

9. A process according to any one of the preceding claims, wherein dried sludge is fed to, and char removed from the reactor, by a means to ensure no ingress of air into the reactor, or egress of vapours from the reactor.

10. A process according to any one of the preceding claims, wherein the temperature of the reactor is at least about 250°C.

11. A process according to any one of the preceding claims, wherein the temperature of the reactor is about 400 to 450°C.

12. A process according to any one of the preceding claims, wherein the process further comprises the additional step of drying the material to be converted to less than 5% moisture prior to introduction to the reactor.

13. An apparatus for the conversion of sludges and carbonaceous materials, the apparatus characterised by comprising a reactor having a heating zone and a reaction zone and a means for conveying the material through both zones of the reactor in turn, the heating zone having a material inlet and the reaction zone having a material outlet and a gaseous product outlet, wherein there is further provided a retention means for retaining the material within the reactor such that a desired Weight Hour Space Velocity ("WHSV") for the material is achieved.

14. An apparatus according to claim 13, wherein the means for conveying material is a conveyor that allows a level of back mixing of the material being conveyed.

15. An apparatus according to claim 14, wherein the conveyor comprises in part an elongate shaft along at least a portion of the length of which are provided a plurality of paddles extending radially therefrom arranged to engage a bed of the material to be conveyed therethrough.

16. An apparatus according to claim 15, wherein the paddles are provided in a single row helical arrangement along the elongate shaft.

17. An apparatus according to claim 16, wherein the paddles overlap along the length of the shaft.

18. An apparatus according to any one of claims 15 to 17, wherein the paddles are spaced radially from adjacent paddles by between 30 to 90°.

19. An apparatus according to claim 18, wherein adjacent paddles are spaced apart by about 72°.

20. An apparatus according to any one of claims 15 to 19, wherein every second paddle is pitched at a back angle towards the material inlet.

21. An apparatus according to claim 20, wherein the back angle is about 10°.

22. An apparatus according to any one of claims 13 to 21, wherein the retention means is provided in the form of a weir.

23. An apparatus according to claim 22, wherein the weir is positioned within the reactor at a point immediately before the solids material outlet.

24. An apparatus according to claim 22 or 23, wherein the weir is tilted or rotated within the reactor with respect to the shaft of the conveyor so as to approximate the tilt or rotation of the bed of material provided therein.

25. An apparatus according to claim 24, wherein the weir is rotated through 30° to the horizontal.

26. An apparatus according to any one of claims 22 to 25, wherein the weir is adjustable in height.

27. A process for the conversion of sludges and carbonaceous materials substantially as hereinbefore described with reference to the accompanying figures.

28. An apparatus for the conversion of sludges and carbonaceous materials substantially as herein before described with reference to Figures 2 to 4, or Figures 6 to 8.